

ARTICLES

THE HERPETOFAUNA OF LETTERKENNY ARMY DEPOT, SOUTH-CENTRAL PENNSYLVANIA: A STARTING POINT TO THE LONG-TERM MONITORING AND MANAGEMENT OF AMPHIBIANS AND REPTILES

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Abstract: We surveyed the herpetofauna of the Letterkenny Army Depot (LEAD), Franklin County, in south-central Pennsylvania during May to September of 2003 and 2004, using a variety of techniques: cover boards, drift fences, pit falls, funnel traps, and road cruising. We identified 15 species of amphibians and 14 species of reptiles. The most abundant amphibian was the American Toad (*Anaxyrus americanus*) with 34.7% of total amphibian captures, followed by the Bronze Frog (*Lithobates clamitans*), with 21.8%. The most abundant reptile was the Eastern Box Turtle (*Terrapene carolina*), which yielded 62.0% of the total reptilian captures, followed by both the Five-lined Skink (*Plestiodon fasciatus*) and the Eastern Racer (*Coluber constrictor*) with 5.3% each. Endangered or threatened species such as the Eastern Mud Salamander (*Pseudotriton montanus*), Bog Turtle (*Clemmys muhlenbergii*), Eastern Redbelly Turtle (*Pseudemys rubriventris*), and Rough Green Snake (*Opheodrys aestivus*), although historically present in this region, were not detected in our study. This effort was the first standardized and comprehensive assessment of species composition and abundance of amphibians and reptiles at LEAD. Although it is likely that past anthropogenic disturbances have detrimentally affected the herpetofauna of this site, the current monitoring effort and management plan are positive signs for the future. Our findings underscore the importance of continued monitoring for a more complete inventory, with special attention being paid to assessing the status of sensitive species and the potential for colonization of exotic species currently known to be in Pennsylvania.

Introduction

Pennsylvania is home to 77 species of amphibians and reptiles, all but one of which are native (Hulse et al., 2001). For millennia, amphibians and reptiles worldwide have endured pervasive negative consequences from anthropogenic activities, such as agricultural, industrial, and urban development (Mitchell et al., 2008). But even when natural habitats have been deeply impacted by anthropogenic factors, such as destruction, pollution, and fragmentation, they might still provide suitable refugia for native herpetofauna (Mifsud and Mifsud, 2008). In Pennsylvania, Letterkenny Army Depot (LEAD) is a large and relatively protected site conducive to long-term community assemblages and natural history studies.

A species list of the herpetofauna is the logical first step in a long-term monitoring project of this segment of the biota begun by Pablo Delis at LEAD in 2002. Thus, the objectives of our research were to characterize the current herpetological community at this mid-size Department of Defense parcel of forests, field, and aquatic systems located in the

Kittatinny Mountains ridge and Cumberland Valley of south-central Pennsylvania. Specifically, we determined species composition and relative abundance of the amphibians and reptiles. We wanted to compare the herpetological community currently present at the site with that expected from prior literature (Felbaum, 1995; Hulse et al., 2001; Tetra Tech, Inc. 2001; Shaffer, 1999). It is our intention that this study will provide a first step in bringing to light the data necessary for the understanding and management of the herpetofauna in this large and protected natural resource.

Study Area

Letterkenny Army Depot (LEAD) is located in Franklin County, south central Pennsylvania. It is a federally-owned parcel of approximately 7,000 ha in area, located Latitude 39°58'N and Longitude 77°42'W. This holding is composed of mild hills and valleys that range 180 to 309 m in elevation with a variety of wetlands such as creeks, reservoirs, and vernal pools. The vegetation is dominated by mixed deciduous forest and by disturbed meadows that are impacted by

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agricultural and other human activities (Figure 1). Most of our fieldwork was conducted in the buffer zone of LEAD otherwise known as Zone II, located in the northwest sector of the installation at the base of North Mountain along the Kittatinny ridge of the Blue Mountain range. Federal protection, and the combination of relatively pristine areas located alongside heavily disturbed sites, makes this area an ideal study site for long-term field studies with resource management implications.

Materials and Methods

Data Collection: Our study took place from May of 2003 to September of 2004. To estimate the presence and relative abundances of the herpetofauna, we used a combination of passive trapping, active trapping, and diurnal/nocturnal unevenly spaced transects throughout the year to maximize success. We deployed six trap arrays, which are combinations of 6 m drift fences, 20-L bucket pitfall traps, and 50 cm x 25 cm x 25 cm funnel traps (Heyer et al. 1994), randomly distributed throughout the available natural areas at LEAD Zone II. We also distributed aluminum sheets (1 m x 2.75 m) as cover boards in specific transects, at disturbed and undisturbed locations.

We conducted surveys on foot and by road cruising along separate transects on sunny and rainy days and on rainy nights during spring-winter. Late spring, summer, and early fall were surveyed more often than other times of the year. Diurnal walking transects consisted of following routes where we turned logs, inspected depressions or crevices, and caught, when possible, individual animals to confirm identification. Walking transects alternated in early hours of the day, at noon, and in the evenings to account for behavioral differences in target species. Transects covered at least 10% of the surface area of interest as per recommendations by Heyer and coworkers (1994). Nocturnal anuran chorus surveys took place sporadically on rainy nights, especially in the interval between late spring and early fall. We listened for at least three minutes in key locations to detect the presence of calling males. We identified species and recorded rough estimates of abundance as per the method of Delis (2001). We employed dip netting and seining in the various wetlands to determine the presence of amphibian larvae and the presence of exclusively aquatic species. For some species, and when logistically feasible, captured individuals were measured, weighed, assessed with respect to their reproductive status, occasionally photographed, and permanently marked following standard biological tech-

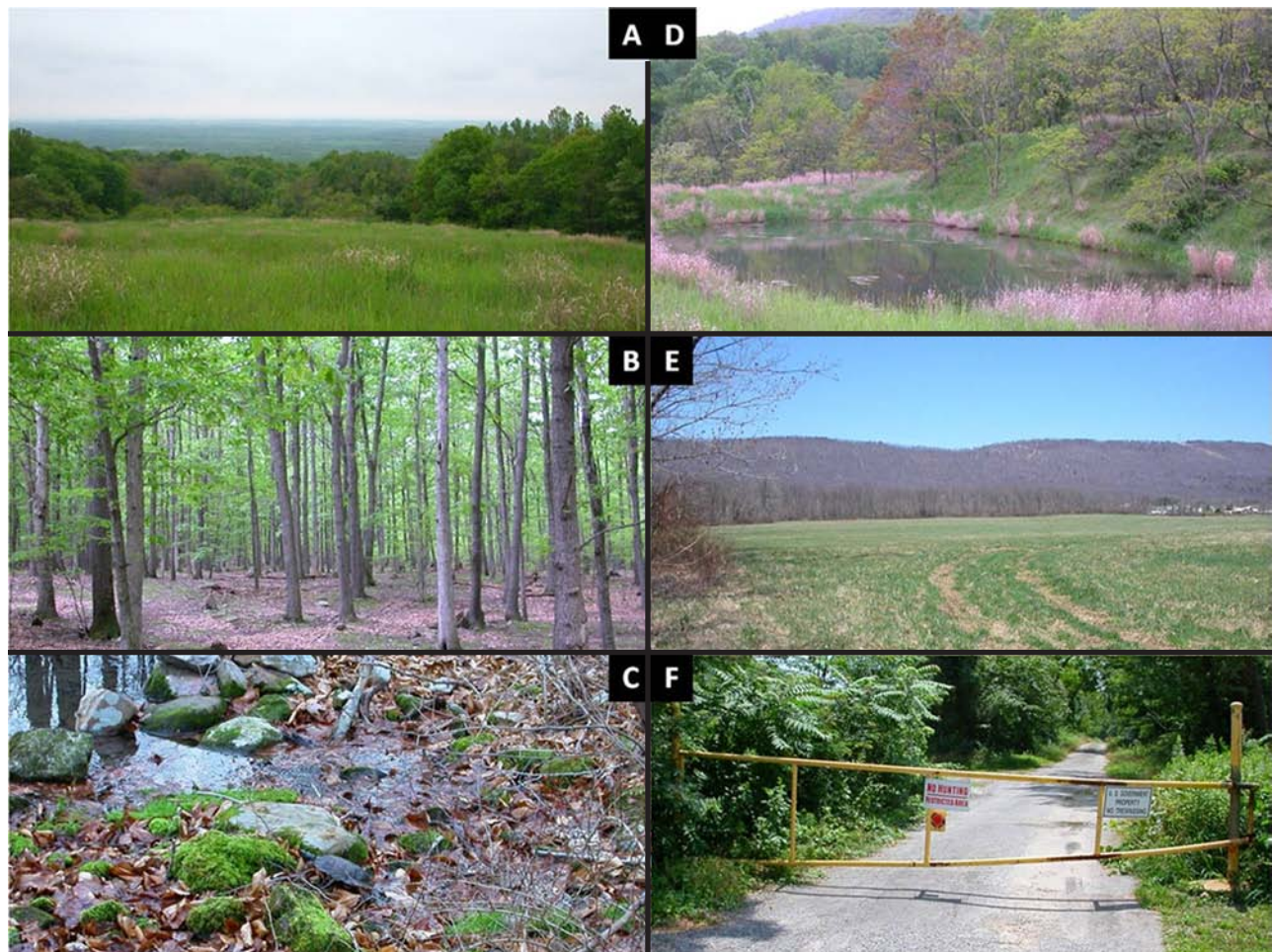


Figure 1. Some of the views and habitats characteristic of Letterkenny Army Depot (LEAD) Zone II, south central Pennsylvania. A = open meadows, B = deciduous temperate forest, C = springs and creeks, D = vernal pools, E = agricultural fields, F = roads and fences.

niques (Heyer et al., 1994). All marked individuals were released at their capture sites. Vouchers of selected species are deposited in the Section of Zoology and Botany of the State Museum of Pennsylvania, Harrisburg.

Data Analysis: Species composition was derived from pooling together all species encounters from all the different techniques employed during this survey. We compared our findings with those expected from prior literature (Hulse, et al., 2001; Tetra Tech, Inc. 2001; Mark Zimmerman, Unpubl. data). We assessed the amphibian and reptile communities by using lists of species richness and species composition. To determine relative abundance, we used only the records obtained in traps and on timed walking/driving transects. We divided the total number of individuals of a given species for the whole duration of this survey by the total number of encounters of all of the species of both the amphibians and reptiles separately. We are aware of the weaknesses and biases of this rough analysis but also realize that, in spite of its limitations, these data provide sufficient estimates of richness and evenness for comparison with long-term, targeted, and rigorous demographic accounts of the herpetological community at this location.

Results and Discussion

In the 16 months of our study, we detected 15 species of amphibians (Table 1) in Zone II of LEAD. Based on captures only, the two most abundant amphibians were the American Toad (*Anaxyrus americanus*) (Figure 2), with 34.7% of total amphibian captures ($n = 709$), and the Bronze Frog (*Lithobates clamitans*) with 21.8% (Figure 3). Comparatively, our species list for amphibians represented 78.9% of the 19 amphibians reported from LEAD during 2000–2002 (Zimmerman, Unpubl. data), 52.0% of the 25 species predicted to occur at LEAD by the Integrated Natural Resources Management Plan (INRMP) (Tetra Tech, Inc. 2001), and 60.0% of the 25 species reported from Franklin County (Hulse et al., 2001). The Bullfrog (*Lithobates catesbeianus*) was detected exclusively and sporadically through male calls. Because no individuals were captured, this species was excluded from the relative abundance analyses.



Figure 2. A rusty colored American Toad (*Anaxyrus americanus*), a common morph in our experience at this site, had the highest relative abundance among amphibians at Letterkenny Army Depot, Zone II, in south-central Pennsylvania during our 2003–2004 survey.

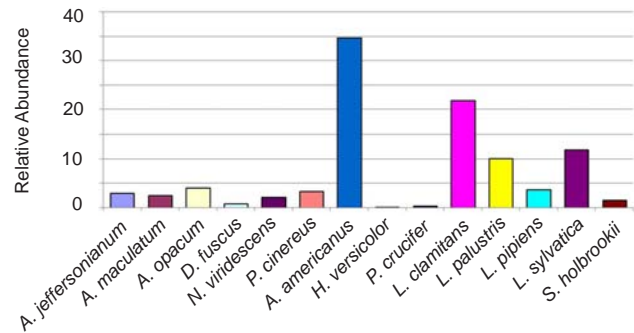


Figure 3. Percent relative abundance of amphibian species, in percent encounter per total number of individuals sighted ($n = 709$) at LEAD, Zone II, in south-central Pennsylvania during 2003–2004.

During that same study period, we detected 14 species of reptiles (Table 2) in Zone II. The most abundant reptile was the Eastern Box Turtle (*Terrapene carolina*), which accounted for 62% of the total captures of reptiles (Figure 4). The Five-lined Skink (*Plestiodon fasciatus*) and the Eastern Racer (*Coluber constrictor*) were the second most abundant reptiles at LEAD, during our study, each accounting for 5.3% of all reptile captures ($n = 56$). Comparatively, we found two

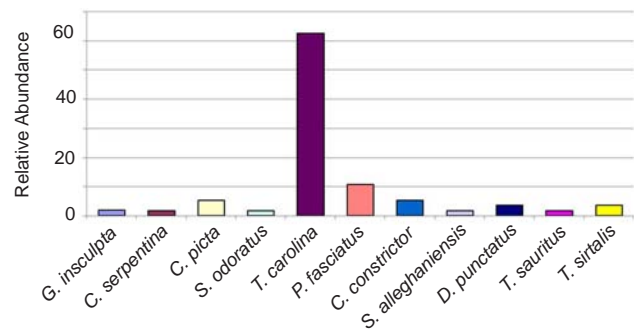


Figure 4. Percent relative abundance of reptile species, in percent encounter per total number of individuals sighted ($n = 56$) at LEAD, zone II, in south central Pennsylvania during 2003–2004.

more species than the twelve reported from LEAD during 2000–2002 (Zimmerman, unpubl. data), we found 56.0% of the 25 species predicted to occur at LEAD from the INRMP (Tetra Tech, Inc. 2001), and we found 63.6% of the 22 spe-

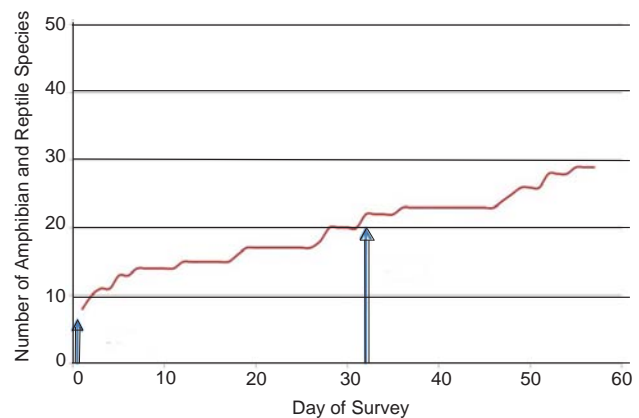


Figure 5. Daily cumulative number of species captured at LEAD, zone II, in south central Pennsylvania using all methods during 2003–2004.

Table 1. List of species of amphibians at Letterkenny Army Depot, Franklin County, Pennsylvania under different time and survey circumstances. The list of species, on the left, represents all the amphibians found in Pennsylvania (Hulse et al. 2001). Orange highlight indicates endangered species. 1 = amphibians present in Franklin County, Pennsylvania, and may be found in LEAD, Integrated Natural Resources Management Plan (Tetra Tech, Inc. 1999). 2 = amphibians in south-central Pennsylvania (Hulse et al., 2001), 3 = amphibians positively identified "in situ" by Mark Zimmerman during 2000-2002. 4 = amphibians positively identified "in situ" in the present survey 2003-2004. * = species considered endangered by the Commonwealth of Pennsylvania (Felbaum, 1995). ** = species considered threatened by the Commonwealth of Pennsylvania (Felbaum, 1995).

Scientific Name	1	2	3	4
Salamanders (21 species)				
<i>Cryptobranchus alleganiensis</i>	Y	N	N	N
<i>Necturus maculosus</i>	N	N	N	N
<i>Ambystoma jeffersonianum</i>	Y	Y	Y	Y
<i>Ambystoma maculatum</i>	Y	Y	Y	Y
<i>Ambystoma opacum</i>	Y	Y	Y	Y
<i>Notophthalmus viridescens</i>	Y	Y	Y	Y
<i>Aneides aeneus</i> **	N	N	N	N
<i>Desmognathus fuscus</i>	Y	Y	Y	Y
<i>Desmognathus monticola</i>	N	N	N	N
<i>Desmognathus ochrophaeus</i>	Y	Y	N	N
<i>Plethodon cinereus</i>	Y	Y	Y	Y
<i>Plethodon electromorphus</i>	N	N	N	N
<i>Plethodon glutinosus</i>	Y	Y	Y	N
<i>Plethodon hoffmani</i>	Y	Y	Y	N
<i>Plethodon wehrlei</i>	N	N	N	N
<i>Hemidactylium scutatum</i>	Y	Y	N	N
<i>Gyrinophilus porphyriticus</i>	Y	Y	N	N
<i>Pseudotriton montanus</i> *	N	N	N	N
<i>Pseudotriton ruber</i>	Y	Y	Y	N
<i>Eurycea bislineata</i>	Y	Y	Y	N
<i>Eurycea longicauda</i>	Y	Y	Y	N
Toads and Frogs (14 species)				
<i>Scaphiopus holbrookii</i>	N	N	N	Y
<i>Anaxyrus americanus</i>	Y	Y	Y	Y
<i>Anaxyrus woodhousii</i>	Y	Y	N	N
<i>Acris crepitans</i>	Y	Y	Y	N
<i>Hyla versicolor/Hyla chrysoscelis</i> complex	Y	Y	Y	Y
<i>Pseudacris brachyphona</i>	N	N	N	N
<i>Pseudacris crucifer</i>	Y	Y	Y	Y
<i>Pseudacris triseriata</i>	Y	Y	N	N
<i>Lithobates catesbeianus</i>	Y	Y	Y	Y
<i>Lithobates clamitans</i>	Y	Y	Y	Y
<i>Lithobates palustris</i>	Y	Y	Y	Y
<i>Lithobates pipiens</i>	N	Y	N	Y
<i>Lithobates sphenoccephalus</i>	N	N	N	N
<i>Lithobates sylvaticus</i>	Y	Y	Y	Y
Total (35 species)	25	25	19	15

cies reported from Franklin County (Hulse et al., 2001). The net increase of two species of reptiles from Zimmerman's data is explained by the detection of the Northern Water Snake (*Nerodia sipedon*), Eastern Ribbon Snake (*Thamnophis sauritus*), Timber Rattlesnake (*Crotalus horridus*), and Common Musk Turtle (*Sternotherus odoratus*) during our survey. In turn, we did not detect the Eastern Hognose Snake (*Heterodon platirhinos*) or the Spotted Turtle (*Clemmys guttata*) in Zone II. Interestingly, no Sliders (*Trachemys scripta*) were detected at LEAD despite the growing presence of this exotic species in Pennsylvania.

Based on our 16-month survey, the species list for LEAD contains just over one half of the expected species richness

in the region, and we consider this a preliminary estimate. The species not detected in Zimmerman's survey could be argued to have been no more or less remarkable than what we detected, such as the Bog Turtle versus the Eastern Spadefoot, as compared to the species that he did not find. Because the rate of species discovery in the region continued to increase over the duration of our study (Figure 5), we are confident that the gap in species expected versus those detected would be closed as more time and targeted techniques are used in the future. Thus, we believe that both Zimmerman's and our studies, best serve as snap shots subjected to sampling constraints. The differences between our survey and Zimmerman's are small and seem to us to be

Table 2. List of species of reptiles at Letterkenny Army Depot, Franklin County, Pennsylvania under different time and survey circumstances. The list of species, on the left, represents all the reptiles found in Pennsylvania (Hulse et al. 2001). Orange highlight indicates endangered species. 1 = reptiles present in Franklin County, Pennsylvania, and may be found in LEAD, Integrated Natural Resources Management Plan (Tetra Tech, Inc. 1999). 2 = reptiles in south-central Pennsylvania (Hulse et al., 2001), 3 = reptiles positively identified "in situ" by Mark Zimmerman during 2000-2002. 4 = reptiles positively identified "in situ" in the present survey 2003-2004. * = species considered endangered by the Commonwealth of Pennsylvania (Felbaum, 1995). ** = species considered threatened by the Commonwealth of Pennsylvania (Felbaum, 1995).

Scientific Name	1	2	3	4
Turtles (14 species)				
<i>Chelydra serpentina</i>	Y	Y	Y	Y
<i>Sternotherus odoratus</i>	Y	Y	N	Y
<i>Kinosternon subrubrum</i>	N	N	N	N
<i>Clemmys guttata</i>	Y	Y	Y	N
<i>Glyptemys insculpta</i>	Y	Y	Y	Y
<i>Clemmys muhlenbergii</i> *	Y	N	N	N
<i>Terrapene carolina</i>	Y	Y	Y	Y
<i>Emydoidea blandingii</i>	N	N	N	N
<i>Graptemys geographica</i>	Y	Y	N	N
<i>Chrysemys picta picta</i>	N	N	N	N
<i>Chrysemys picta marginata</i>	Y	Y	Y	Y
<i>Pseudemys rubriventris</i> **	Y	N	N	N
<i>Apalone spinifera</i>	N	N	N	N
<i>Apalone mutica</i>	N	N	N	N
Lizards (4 species)				
<i>Sceloporus undulatus</i>	Y	Y	N	N
<i>Plestiodon anthracinus</i>	Y	N	N	N
<i>Plestiodon fasciatus</i>	Y	Y	Y	Y
<i>Plestiodon laticeps</i>	N	N	N	N
Snakes (20 species)				
<i>Nerodia sipedon</i>	Y	Y	N	Y
<i>Storeria dekayi</i>	Y	Y	N	N
<i>Storeria occipitomaculata</i>	Y	Y	N	N
<i>Thamnophis sauritus</i>	Y	Y	N	Y
<i>Thamnophis sirtalis</i>	Y	Y	Y	Y
<i>Thamnophis brachystoma</i>	N	N	N	N
<i>Heterodon platirhinos</i>	Y	Y	Y	N
<i>Diadophis punctatus</i>	Y	Y	Y	Y
<i>Coluber constrictor</i>	Y	Y	Y	Y
<i>Liochlorophis vernalis</i>	Y	Y	N	N
<i>Opheodrys aestivus</i>	N	N	N	N
<i>Scotophis alleghaniensis</i>	Y	Y	Y	Y
<i>Lampropeltis triangulum</i>	Y	Y	Y	Y
<i>Clonophis kirtlandii</i>	N	N	N	N
<i>Carphophis amoenus</i>	N	Y	N	N
<i>Regina septenvittata</i>	N	N	N	N
<i>Virginia valeriae</i>	N	N	N	N
<i>Agkistrodon contortrix</i>	Y	N	N	N
<i>Crotalus horridus</i>	Y	Y	N	Y
<i>Sistrurus catenatus</i>	N	N	N	N
Total (38 species)	25	22	12	14

best explained by sampling biases in timing or technique.

We are optimistic in that the current habitat use at LEAD, and especially within Zone II, where this survey took place, seems to be compatible for a well represented Pennsylvania native herpetofauna. Zone II has not been subjected to harsh alterations experienced by the rest of LEAD for over a decade. In fact, a minimum harvesting of secondary growth deciduous forest, marginal and low impact agricul-

tural practices, few and barely utilized roads, strong restrictions in access, and Natural Resources Office monitoring at the base, have been fostering better conditions for the future of the site.

In our opinion, however, it is critical that long-term efforts to survey and monitor the status of species composition and abundance of the amphibians and reptiles at LEAD be continued. The focus on endangered or threatened spe-

cies should be matched with robust studies of demographic trends in apparently common, or safe, species such as the Pickerel Frog, the Eastern Racer, or the Eastern Box Turtle. Future conservation endeavors, should also contemplate the need to enact several habitat restoration efforts, including wetlands, critical to amphibians and aquatic reptiles. For the future, and as more ambitious goals, we may consider desirable species reintroductions, potentially, including the sensitive species historically expected in the region, for instance the Eastern Mud Salamander, the Bog Turtle, the Eastern Redbelly Turtle, and Rough Green Snake.

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